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ABSTRACT

The report presents a synthesis of approximately 85 books, journal articles, and research studies published between 1959 and 1977 on future studies, process education, and inventive problem solving. Future studies are defined as studies which require students to learn about the future and to anticipate change. Process education is defined as an instructional approach that focuses on teaching skills rather than content. Inventive problem solving is defined as a method involving definition of a problem, formulation of a hypothetical solution, and testing of the hypothesis until evidence warrants its acceptance. The document is presented in four sections. Section I offers background information on a future studies curriculum development project (Making Changes) initiated by Research for Better Schools in 1970. Section II reviews literature on problem solving, process education, and implications of instructional techniques for curriculum development. Section III synthesizes future studies literature. Topics include research on the future and on future studies and goals of future studies courses. The final section outlines objectives for the Making Changes program and presents a classification scheme of cognitive and affective objectives for courses in futures studies based on a problem-solving approach. (DB)

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INVENTIVE PROBLEM SOLVING AND FUTURE STUDIES

by

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Inventive Problem Solving and Future Studies: A Review and Synthesis

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BACKGROUND

I. A HISTORY

The development effort for the *Making Changes* program began in 1970. Under a contract from the Office of Education, the Humanizing Learning Program of Research for Better Schools began an extensive literature search with the idea of constructing a "Higher-Order Cognitive Curriculum." By December of 1971, the following products were completed: a review of the literature related to direct instruction in cognitive skills; a review and summary table of models of cognitive processes; a taxonomy of cognitive objectives addressed by 54 instructional programs selected for their focus on cognitive skills and processes; a "higher-order cognitive" taxonomy; and a preliminary set of objectives designed to provide instruction in six skill clusters identified as areas of need.

The six skill areas and their major subcategories as well as the tentative names for the six instructional packages are listed below (Thomas, 1972):

HIGHER ORDER COGNITIVE SKILLS TAXONOMY

I. Learning to Learn Skills - "Making it Easy"
   - Attending and Orienting
   - Decoding
   - Memorizing
   - Studying

II. Communication Skills - "Making Sense"
   - Observing
   - Describing
   - Explaining
   - Discussing

III. Classifying and Comparing Skills - "Making it Clear"
- Differentiating and Grouping
- Classifying
- Ordering
- Comparing
- Using Numbers

IV. Synthesizing and Producing Skills - "Making Changes"
- Inventing
- Associating
- Elaborating
- Generating Implications
- Planning
- Solving Problems Using Strategies

V. Skills of Judging and Inferring - "Making Judgments"
- Coding
- Judging
- Inferring
- Testing

VI. Skills of Value Analysis and Decision Making - "Making Decisions"
- Valuing
- Evaluating
- Deciding

As it happened, the first package selected for development was the *Making Judgments* program (skill area VI on the taxonomy). This effort began in December of 1971 and lasted until November of 1975. Although development activities for the second package, the *Making Changes* program did not begin in earnest until Fy '75-76, a complete historical account of the program must include mention of a second conceptualization of the program completed in the Spring of 1975, entitled, *Prospectus: Making Changes - A future-oriented course in divergent problem-solving skills for middle-school age students.*

The original plan for the *Making Changes* program was to construct a self-instructional package which would focus essentially on training

students to use their imagination. Based on experience with the development and testing of the *Making Judgments* program and on ideas picked up from the emerging literature on "future studies," the decision was made to change the structure of the *Making Changes* program from a self-instructional format to a teacher-led format and to change the focus to one that emphasized issues and problems of alternative futures. Accordingly, the prospectus mentioned above included goal statments organized into five areas. Here is an excerpt from the goals section of the prospectus (Thomas, 1975):

> MAKING CHANGES: GOALS
>
> The *Making Changes* curriculum is based on five integrated goals of instruction:
>
> Futurism: Planning and forecasting
>
> Students would benefit from a course of instruction designed to acquaint them with some of the problems that have been projected for the future, and with some of the problem-solving techniques used by futurists and planners. More important, students would benefit from a course that teaches strategies and skills of planning, value analysis and forecasting while making students responsible for projecting problems, suggesting solutions and evaluating the consequences of their solution ideas.
>
> Problem Solving: A model for defining and solving open-ended problems
>
> Students would benefit from learning a generalizable problem-solving strategy and from applying this process to a variety of problems. Instruction in this approach must proceed in such a way that students become able to use the strategy autonomously on a problem of their own choosing.
>
> Divergent Thinking: Strategies for generating ideas
>
> There is reason to believe that students would benefit from learning some of the techniques found to be useful by practitioners for defining, analyzing and suggesting solutions for open-ended

problems. Techniques of idea generation (referred to elsewhere as creative problem-solving strategies, or divergent-thinking skills) should constitute especially worthwhile objectives when practiced in the context of problem-solving ventures involving current and anticipated "realistic" problems.

Group Skills: Techniques for managing time and tasks

Students would benefit from practicing the skills and strategies described above in both individual and group situations. Accordingly, students need to learn some of the self-management and group-process skills found to facilitate productive group-solving activities.

Disposition and Attitudes:

Students would benefit from a course of instruction designed to effect changes in their attitudes regarding the future, their willingness to make contributions to group activities, their receptivity and flexibility to change, their resistance to habit and functional fixedness, their tolerance of others' ideas and their confidence in their own abilities to produce original solutions.

The complete prospectus, which included a brief review of the literature for each of the goal areas above, a rationale and needs statement for the program, as well as a description and preliminary set of objectives, was sent to 60 scholars and practitioners for review. Virtually all of the 42 respondents affirmed the need for a program similar to the proposed effort and supported the goals and method outlined in the paper. The development of the *Making Changes* materials was initiated as a direct result of this survey and has been guided and shaped by the specific suggestions and criticisms contributed by the respondents.

II. CONTRIBUTIONS FROM THE LITERATURE

The major emphases of the *Making Changes* program are inventive problem-solving and futures studies. Before presenting a review of salient findings and recommendations in these areas, the following caveats should be instructive.

- The phrase "inventive problem solving" is used rather than "creativity" or "creative problem solving" in order to prevent misconceptions. For different people, the term "creativity" may mean a personality trait, a method of teaching, a cognitive style variable, a determinant of artistic talent or a dimension of cognitive abilities. The *Making Changes* program is not designed to alter personalities or to teach talent, nor is it meant to be a program for creative or gifted students alone. One of the initiating premises of the program is that all students, with the possible exception of the manifestly creative, can benefit from direct instruction designed to improve their skills at defining and solving open-ended problems.
- The literature on creativity and creative problem solving is replete with wisdom regarding how to make students more creative. The vast majority of these suggestions are unaccompanied by evidence for their validity. Moreover, despite the volumes of research in the area, the reader interested in teaching students (children and adolescents) how to go about solving open-ended problems has only a handful of original sources to rely upon (i.e., Parnes and associates at the State University of New York at Buffalo, Guilford and associates at

UCLA, Davis and associates at the University of Wisconsin, Feldhusen and associates at Purdue, Covington and associates at Berkeley and DeBono at Cambridge).

- Research literature on futures studies, alternately called futuristics, futurology, or futurism, is virtually non-existent. A number of authors have proposed objectives, methods and teaching strategies but to date, no research is available on the attainability of these objectives or the effectiveness of the proposed methods.

The review is divided into three major sections: process education, inventive problem solving and futures studies. The process education section is included in order to provide a brief notion of the philosophical or pedagogical roots of the development effort. The section on inventive problem solving includes research relevant for both the "problem solving" and "divergent thinking" goal areas. Finally, research studies related to the remaining goal areas, "group skills" and "attitudes and dispositions," are included within the "futures studies" and "inventive problem solving" sections.

A. Process education

"Process education" is a phrase that became popular during the late 1960's to describe an approach to instruction that focuses on teaching skills rather than content; teaching the operations or processes of a discipline rather than its structure; assessing students competence at performing operations rather than testing for understanding or recall. According to Cole (1972) in his book, Process Education:

> Process education recognizes that people live by their skills. Both the productivity and quality of life are related to the skills of learning, of relating to others, of empathy, of analyzing and synthesizing information and experience, of planning and implementing action, of conceptualizing, generalizing, expressing, and valuing are a few of those by which we live. *People do not live by information. The information is needed, but without the skills to act on the information, the person is crippled. The power lies not so much in the information as in the skills to organize and use it, to make meaning from it. (p. 4.)*

Perhaps the most radical statement for process education was contributed by a psychologist who might otherwise be considered to be a behaviorist. Rohwer (1971) reviewed a number of studies of early childhood and compensatory education and concluded that early childhood may be an inefficient period in which to try to teach skills that can be learned more quickly in adolescence (reading, computation, concepts and principles of science, etc.). Rohwer went on to propose that the principal goal of education should be to assist the student to be adaptive with respect to extra-school tasks.

> It is plausible to presume that the components of this goal prominently include the following three: (1) to promote the student's acquisition of a repertory of skills for accurately locating and efficiently learning new information and new skills; (2) to promote the student's acquisition of a repertory of skills for extending information, creating information, and for solving problems; (3) to promote the student's acquisition and maintenance of motivational systems that will incline him to engage in learning and problem solving. (p. 325.)

Rohwer's article is important for a number of reasons. First, his position lends research support to that of other psychologists and educators more closely identified with the process education movement: Gagné's (1965) emphasis on the permanence and transferability of

intellectual skills; Bruner's (1961) promotion of the discovery learning method; Covington's (1970) proposal for a cognitive curriculum which would emphasize coginitive strategies and master thinking skills; and Rubin's (1969) views that the objectives of schooling should focus on those "life skills" that students will have to possess in order to cope with the rapidly changing present and unforeseen futures.

A second reason for selecting Rohwer's article as significant is that Rohwer is not merely saying that skills are important but is saying that skill instruction must lead to autonomous competence with respect to those skills. In other words, schools have not done their job until it can be shown that students not only have mastered the skills but can perform the particular operation in the absence of environmental prompts and guidance. Third, Rohwer introduces another variable into the discussion of what to teach, namely, when to teach. For Rohwer, it makes little sense to teach a body of content or a set of skills unless students are intellectually or developmentally ready to apply the learnings. Fourth, Rohwer makes the point that a particular set of objectives is appropriate for a particular student if and only if the attainment of those objectives has some immediate payoff for that student's out-of-school proficiency at some extra-curricular task (lateral transfer). Alternately, the payoff may be increased proficiency at some task which is presumed to be important after schooling has ceased (horizontal transfer).

To summarize, the *Making Changes* program was guided by a conception of instruction that is relatively less concerned with what students know and can do when prompted and more concerned with what students are

able to do on their own when instruction has ceased. This emphasis on autonomy and on proficiency may explain the heavy emphasis within the program on cognitive strategies rather than content as well as the importance of such indices as the Proficiency Test and The Scenario described in this report.

B. Inventive Problem Solving

> Skills of thinking can be trained. There are skills of becoming aware of a problem, of formulating the problem, or organizing the necessary evidence, of generating many ideas, and of judging the quality of the solution. Each of these skills can be cultivated through specific procedures, and each is enchanced by regular exercise. Productive thinking is a complex process which must be an educational end to itself — it is not the automatic result of other kinds of learning.
>
> Rubin (1969) in Life Skills in School and Society

It is possible to classify all problem-solving activities into three general types (Getzels, 1975) according to what is known and what is unknown. In "type-case 1," the problem solver has been given the problem and knows the method for obtaining the solution. The subject must work out the problem according to the formula given. In "type-case 2," only the problem is given. Neither the method for solving the problem nor the solution are known to the problem solver, although both are known to others. A "type-case 3" problem is considerably less structured. Here the problem itself must be discovered and the method and solution are known neither to the problem solver nor to others.

Most school activities labeled as problem solving fall under the type-case 1 heading. Arithmetic and laboratory science problems place a premium on the accurate recall and application of a learned method.

The use of type-case 2 problems in instruction can be found occasionally in inquiry or discovery learning programs and, especially, in books on puzzles and brain teasers. Type-case 3 problems, on the other hand, rarely serve as the focus of instruction despite the fact that true inventiveness and the majority of "real-life" problem-solving demands involve situations where sensitivity to problems, the ability to define and analyze a problem, and the generation of ideas are more crucial than the recall of known methods.

According to Newell, Shaw and Simon (1962), type-case 3 problem solving, typically referred to as creative problem solving, has four defining features:

1. The product of the problem-solving process has both novelty value and value for the individual or for society.
2. The thinking involved is unconventional. That is, it requires the modification or rejection of previously accepted ideas.
3. The thinking requires high motivation and persistence and usually takes place over a considerable span of time.
4. The problem as initially posed is vague and undefined. Part of the task is to produce a clear and productive formulation of the problem.

Facilitating students' performance on creative or type-case 3 problem solving (hereafter referred to as inventive problem-solving) tasks has been the concern of a number of investigations. Research and development activities in this area have taken two related forms: increasing the number and quality of students' ideas through the use of specific instructional techniques or conditions; and designing comprehensive programs to teach a multi-stage problem-solving model in addition to

specific techniques.

Increasing the Production of Ideas

In 1950, J. P. Guilford delivered an address to the American Psychological Association which raised a number of questions regarding the nature and nurture of creative or divergent-thinking abilities. Subsequent research by Guilford and his associates resulted in the formation of a model of the intellect; the positing of divergent-thinking abilities as distinct from IQ and the convergent thinking emphasized by schools; and the development of measures of divergent thinking. Much of the research concerned with improving creative-thinking abilities relates closely to Guilford's conception of the divergent-thinking dimension. For Guilford and others, divergent thinking is characterized by fluency, the production of many ideas; flexibility, the production of ideas that span multiple categories or that imply different approaches to the problem; and originality, the production of novel, unusual and high quality (elegent, workable, efficient, practical) ideas.

One of the earliest "idea generation methods" to be investigated was brainstorming. Brainstorming is a technique used by Osborn (1963) in the late 1940's and early 1950's as an alternative to the business conference. Participants were given the following rules or principles: (1) criticism is ruled out, (2) freewheeling is welcomed, (3) quantity is wanted, and (4) combination and improvement are sought. The key to brainstorming according to Osborn and subsequent evidence was rule number (1), referred to as the "deferred judgment principle." Meadow,

Parnes and Reese (1959) found that instructions to brainstorm according to the deferred judgment principle resulted in more solutions and more high quality solutions compared to an experimental condition wherein college students generated ideas and evaluated these solutions simultaneously. Brilhart and Johnson (1964) compared the performance of two groups on production of ideas and preference for a procedure. In a within-subjects design, college students considered criteria either before or after generating ideas. Consideration of criteria after idea production was associated with 50% more ideas and was the preferred procedure of the two.

One criticism of brainstorming is that it increases productivity but decreases quality in contrast to procedures that emphasize the early consideration of evaluation criteria. Stratton and Brown (1972) compared combined production and judgment training to judgment training, production training and no training. The results showed that the combined training procedure produced higher quality solutions than production training alone and more solutions than judgment training alone.

Other variables that have been studied in relation to brainstorming and then incorporated into subsequent training programs include the effect of extended effort, personal analogies and heterogeneous grouping. Parnes (1961) found that significantly more good ideas are produced later in a brainstorming list than are produced early in the list. Parnes found this to be true even for trained subjects and even for long time periods (15 minutes). Bouchard (1972) compared a standard

brainstorming procedure to one incorporating the technique called "personal analogy." In the personal analogy procedure, students took turns imagining themselves as the object in question (how can a cigar be improved) and submitting ideas in this analogical role. Bouchard found the combined analogy-brainstorming condition to be more effective for producing high quality ideas than the standard procedure.

Brainstorming, when defined by the deferred judgment procedure, can be both a group and an individual technique. But it is usually thought of as a group procedure that is useful for stimulating divergent approaches to a problem through the facilitating effect of hearing and responding to others' ideas. Stein (1975) reviewed the research on brainstorming groups and concluded that groups can contribute more knowledge and information than each of its members; groups tend to produce a greater variety of solution approaches than do individuals; and when all members contribute, there is a greater probability that a solution will be accepted and carried out if it is produced by a group than by an individual. Relatedly, Stein reports that heterogeneous groups tend to produce more high quality ideas than homogeneous groups. Wallach and Kogan (1965) offer one additional advantage of participation in brainstorming groups. If the group members are comfortable with one another, a phenomenon called the "risky shift" frequently occurs whereby participants become less inhibited than they otherwise would be as individuals and are more apt to suggest daring, unusual ideas. Bouchard (1972) proposes the personal analogy method in conjunction

with a "round robin" procedure as an aid to encouraging the risky shift phenomenon.

Before leaving the subject of groups, it should be noted that participating in small group brainstorming sessions may not only be facilitative of fluency, flexibility and originality, but benefit group members in other ways as well. Group participation may foster positive attitudes toward problem solving and the tendency to persevere on tasks (Trow, 1969; Franks and Howard, 1974). Experience with small groups may provide an effective balance of freedom and order, leadership and participation, that may transfer to other situations (Smith, 1963). In addition the experience may facilitate greater appreciation of others' ideas (Schmuck and Schmuck, 1971); "productive patterns of thinking" (McDanield and Mendell, 1975); cooperation (Stanford and Stanford, 1969); and, patience (Mietus, 1966).

Osborn (1963) also advocated the use of checklists or "idea-spurring questions" to assist in the production of ideas. Davis and Roweton (1968) gave college students an abbreviated version of Osborn's checklist to be used to suggest ideas for changing or improving common household objects. Subjects who used a seven-item checklist produced more ideas and more creative ideas than either subjects who used a detailed checklist (Osborn's 73 idea-spurring questions) or subjects who used no checklist at all. Davis, Roweton, Train, Warren and Houtman (1969) found that, like brainstorming, more high quality ideas are produced in the last half of a twenty-minute period with a checklist than are

produced in the first half of that period.

Morphological synthesis is the name given to another technique that seems to facilitate the production of ideas, especially new combinations of ideas. The method involves selecting two qualities or properties of the object to be improved and listing a limited number of change ideas for each of these qualities. The change ideas are placed as the two axes of a matrix or checkerboard and each of the intersections of the matrix is investigated for a possible new idea or combination. Davis et al.,(1969) and Warren and Davis (1969) found that the morphological synthesis technique significantly facilitated the number and quality of ideas produced compared to a control group which received no special instructions.

Insight problems — puzzles or problems that are seemingly unsolvable and require a sudden flash of insight to be solved — have sometimes been used as criterion problems following training in idea generation techniques. Transfer results have been mixed, perhaps because of the lack of a direct and concrete tie between the kinds of associative techniques mentioned above and the understandings required to solve such sophisticated insight problems as the Maier Two-string Problem (Maier, 1931). De Bono (1969) asserts that creativity (of the sort required to perform well on insight problems) is not some special faculty but rather is a defect in the functioning of the system — a temporary lapse in efficiency. De Bono suggests that creativity training consists of a general awareness of the difference between logical or

vertical thinking and non-logical or lateral thinking combined with practice on varieties of problems and experience with varieties of approaches to problems. Biondi (1972) suggests that students need to learn how to redefine problems and suggests exercises in broadening problem statements, altering words included in the problem definition and determining subproblems. Wicker, Weinstein and Yelich (1977) trained college students on reformulating their initial view of problem statements, avoiding overly narrow problem definitions and recognizing unnecessary assumptions. Performance of the trained group was significantly better than that of an untrained group on eight insight problems.

Implications for Instruction

The research reported above was instrumental in guiding the specifications for the *Making Changes* program. The following techniques were employed as a direct consequence of these and related studies:

- extensive practice with brainstorming
- the use of the deferred judgment principle as a strategy and the separation of evaluation from idea generation
- training in the specification of criteria and the judgment of solutions
- provision for extended effort on brainstorming and other techniques
- the combination of brainstorming and personal analogy techniques
- the extensive use of small group activities

- the deliberate encouragement of group participation
- the inclusion of the shortened checklist and morphological synthesis procedure
- deliberate instruction on problem identification and analysis
- the measurement of fluency, flexibility and originality as well as student satisfaction with an activity.

C. Comprehensive Programs in Inventive Problem Solving

Attempts to teach people to solve open-ended (Type-case 3) problems by teaching a step-wise problem-solving process probably began in industrial settings. The Stanford Research Institute commissioned a review of training programs in problem solving conducted at major corporations and universities (Edwards, 1967). Thirty organizations replied of which most were industrial organizations, colleges or consulting organizations. According to Edwards, the nature and scope of these training programs were quite varied yet reported results were quite satisfactory, e.g., "39% increase in improvement projects . . . 2100 new products."

Edwards reports the following factors as important for success:

(1) establishing a psychologically secure atmosphere where all ideas are welcome;

(2) leading participants out of "mental ruts" thereby enabling them to see problems in a different light;

(3) stimulating participants to recognize and circumvent the individual inhibiting factors or blocks to the free play of their imagination;

(4) involving students intellectually by working on something of interest to them and learning by self-determination;

(5) encouraging "cross fertilization" of ideas;

(6) gaining self-confidence and skills by actually solving problems of progressively greater difficulty; and

(7) challenging students to be "open to experience" constantly and to stretch their imagination as far as they can.

A similar survey of creative problem-solving programs for children was conducted by Torrance (1972). Torrance looked at 142 studies which ranged across the grades K to 12 from short-lived experiments to full semester courses. According to Torrance's analysis, the best results were obtained with disciplined approaches like the Osborn-Parnes model developed at the State University of New York at Buffalo. Moreover, differences as measured by increases in divergent-thinking ability (performance on the Torrance Tests of Creative Thinking for the most part) were greatest and most predictable when deliberate teaching was involved.

Before research conducted on the Osborn-Parnes model mentioned above and other creative problem-solving programs is discussed, an inspection of a typical set of performance objectives for a creative problem-solving program might be instructive. The following list was prepared by Treffinger and Huber (1975):

(1) be sensitive to problems;

(2) be able to define problems;

(3) be able to break away from habit thinking;

(4) be able to defer judgment;

(5) be able to see new relationships;

(6) be able to evaluate the consequences of one's actions;

(7) be able to plan for the implementation of ideas;

(8) be able to observe carefully and discover facts;

(9) be able to use effective techniques for discovering new ideas;

(10) be able to refine strange ideas into useful ones;

(11) be able to describe and use a systematic approach to problem solving;

(12) be able to describe the influence of interpersonal relationships in effective creative problem-solving.

Creative problem-solving courses differ in the number and nature of techniques that are taught, in the kind of problems they use for examples and practice, and the extent to which they use learner-generated as opposed to provided problems. Most of the courses and programs, however, emphasize a blend of attitudes, skills and knowledge and employ some variation on the problem-solving model introduced by Dewey (1933).

Dewey	Osborn-Parnes
a difficulty is felt	fact finding
the difficulty is located and defined	problem finding
possible solutions are accepted	idea finding
consequences are considered	solution finding
a solution is accepted	acceptance finding

The Osborn-Parnes model has been under continual development at the Creative Education Foundation in Buffalo. Since 1949, a Creative Problem-Solving Course has been offered each year to students at the

State University. Among the many studies that have grown out of this program, Parnes (1972) found that students who took the program, compared to students who registered but were placed in a control group, showed significant positive gains in quantity of ideas produced, in quality of ideas produced (originality, sensitivity to problems, flexibility) and on a personality factor described as "dominance" (self confidence, self reliance, persuasiveness, initiative, leadership potential). Parnes also found positive transfer to specially constructed tests administered in a university English course and significant positive gains on Guilford indices of cognition, divergent production and convergent production. Moreover, Parnes found these latter gains to increase incrementally over a 43-week period. Earlier, Parnes and Meadow (1960) found that students who had completed the creative problem-solving course some eight months to four years prior, performed significantly better on six out of six tests of quantity and quality of ideas than did control subjects (students who had registered for the course but who for one reason or another did not take it).

A high school version of the Buffalo program was constructed by Reese and Parnes (1970) and administered as a series of 28 programmed booklets. In this experiment, there were three instructional conditions: programmed booklets alone; programmed booklets with teacher-class interaction; and no special instruction. Eight criteria tests were administered measuring a variety of abilities including fluency, flexibility and originality. Results, according to Reese and Parnes,

were unambiguous. Both treatment groups outperformed the control group on all cognitive measures and the group that had continual interaction with a teacher outperformed the teacher-free group. No significant differences were found among the groups on the personality scale.

Perhaps the best known problem-solving or thinking program for children is The Productive Thinking Program developed at the University of California by Covington, Crutchfield, Olton and Davies (1972). The program consists of a series of programmed booklets which introduce students to strategies for defining problems and thinking of ideas in the context of investigating mysteries. The program emphasizes a blend of positive attitudes, skills, methods and a general thinking strategy (problem-solving process). Wardrop et al., (1969) found positive results for the program in facilitating the thinking skills of fifth-grade children, especially skills relating to asking questions, organizing information and drawing conclusions. A study by Treffinger and Ripple (1968) failed to detect differences with a comparable population of elementary school students. The Treffinger and Ripple study used verbal tests of creative thinking and insight problems while the Wardrop et al., study used criterion problems designed for the program.

Among problem-solving programs, the one that places the heaviest emphasis upon the use of idea generation techniques is probably Thinking Creatively: A Guide to Training Imagination developed at the University of Wisconsin (Davis, 1969). The program has four characteristics, according to its author: (1) a positive slant towards change and

innovation; (2) exercises in fluency; (3) techniques for idea combination (part changing, checklist, checkerboard); and (4) humor. Davis et al., (1968) measured the effect of a ten-week exposure to the course on 6th, 7th and 8th grade students. Compared to students who did not take the program, trained students produced from 50% to 91% more ideas on three measures of ideational fluency. Trained students also produced significantly more good ideas on these measures than did untrained students. Significant differences favoring the trained students on an attitude survey were interpreted by the researchers as suggesting that students felt more creative, more appreciative of wild ideas and more aware of the importance of change and innovation as a result of the course.

The creative problem-solving program which departs the most from others in format (but not objectives) is the synectics program developed by Gordon (1961). The synectics program, like the Parnes-Osborn model, involves a problem-solving process, the deferred judgment principle, problem analysis and definition, and techniques to stimulate ideas. In the case of synectics, however, its origins are in group process research and the arts, and its emphases are on analogical and metaphorical thinking. In a synectics session, the goal is to mix rational and nonrational thought. Distinct psychological states are induced by jumping from one to another psychological state through the use of the following "operational mechanisms:" (1) personal analogy (acting out the problem object or question); (2) direct analogy (looking for a comparable situation in some other domain, especially nature); (3) symbolic analogy

(forming a statement of the essential paradox or conflict inherent in the problem); and (4) fantasy analogy (viewing the problem by generating wish statements). In a very important sense, these operational mechanisms or techniques are both ideational techniques and problem definition techniques. The key to the synectics process is developing a more complete understanding of what is called for in a "problem-as-given."

The synectics process has been adapted for elementary and secondary school students (Gordon, 1973; Synectics, 1968). Stein (1975) reports a pilot study of the synectics program conducted on a small group of 9th-grade students. Significant pretest to posttest gains were found on the originality and elaboration scales of the Torrance Tests of Creative Thinking but not on the fluency and flexibility scales. Additional anecdotal and survey data reported by Stein attest to a high degree of satisfaction characteristic of participants in the synectics program.

Implications for Instruction

The programs described above represent only a partial list of the resources available to an investigator interested in improving students' performance on open-ended problems. The above programs were selected for their relevance for the goals of the *Making Changes* program and for the availability of evaluation data. Other books and materials that provided ideas and guidance for the *Making Changes* development effort include: Biondi, 1974; Crawford, 1964; McKim, 1972; and Edwards, 1976.

The following is a partial list of concepts and procedures that were incorporated into the program as a direct result of looking at what others have done and how well they've done it:

- an attempt was made to have students recognize "blocks" and "aids" to thinking
- problems included in the program were selected, in part, for their interest value
- a cumulative learning model was employed such that activities occurring later in the program were more complex and built on previous learnings
- a "disciplined" approach was taken throughout
- an attitude survey was included along with tests of creative thinking and criterion-referenced measures
- the role of the teacher was regarded as crucial for the effectiveness of the materials
- the relative amount and weight of teacher guidance were designed to decline as the program progresses
- the force-fit technique from the Osborn-Parnes program and the part-changing technique from Davis were included in the program
- a separate unit was developed around the concepts and mechanisms of synectics

III. FUTURES STUDIES

> "Let the skills of problem solving be given a chance to develop on problems that have an inherent passion - whether racism, crimes in the street, pollution, war and aggression, or marriage and the family."
>
> Bruner, 1970

> "Nothing is less practical than a practical education if the result is a trained incapacity for adaptation to change . . . the school will fulfill its function as an agency of developmental change only if it prepares its graduates for a somewhat uncertain world where no niche is absolutely secure and few niches even hold their shape well."
>
> Moore, 1967

The accelerating interest in futures studies, referred to by various authors as futuristics, futurism, futurology, forecasting and futures research, is in large measure attributable to the writings of Alvin Toffler. Toffler taught one of the first courses in futures studies in 1966 and his books, Future Shock and Learning for Tomorrow, have inspired other teachers from elementary to graduate school to institute courses on the future.

For Toffler and others, the argument for putting futures studies into the classroom centers on the rapidity of social and technological change. Preparing students to adapt to and cope with these changes requires that students learn not only information about the future but the habit of anticipating change as well. This theme is echoed by a host of futurists and educators. Whether they point to the knowledge explosion (Toffler, 1974), the salience of world problems (Kauffman, 1976b), the necessity to learn long-range planning (Shane and Shane, 1974), or the importance of goal setting (Peakes et al., 1973), the need to effect fundamental changes in students' attitude or orientation toward the future is universally emphasized.

Aside from the recent surge of interest in career education, schools have maintained a past-to-present orientation in most subject matter areas. Futures studies is seen by an increasing number of educators (e.g. Torrance, 1975a) as at least a partial remedy for the discontinuities that seem to exist between the content and demands of the "school world" and the current and anticipated demands of the "real world." Not only do students tend to question the relevance of what they are required to learn in school, but they fail to see the relationship between what they are learning and what they will do when schooling is completed. From a student-centered perspective, futures studies may provide a vehicle for equipping students with what psychologists refer to as a "future-focused role image." This role image is more than, "What will I do when I grow up?" The image includes some notion of what the world might be like, what changes might occur and what personal changes might be required in order to adapt to these possible futures.

As with most new ideas in education, reaching agreement that something should be done is far easier than achieving consensus on goals and methods. Stock (1977), for example, surveyed 573 teachers who were involved in futures studies programs in 184 secondary schools. Goals across these programs were as broad as they were vague:

Goals for Futures Studies Programs

Ranking of Suggested Goal Statements
in Degree-of-Acceptance Categories

<u>High Degree of Acceptance</u>

(1) To stimulate in students the ability to imagine and consider the implications of many alternative possible futures

(2) To help students to realize that the future depends to a great extent on what is happening in the present

(3) To enable students to realize the impact of technology on society

(4) To help students to realize how anticipated future changes may alter their own personal life-styles and aspirations

(5) To help students search for and identify future trends

(6) To strengthen students' practical ability to anticipate and adapt to change

(7) To help students develop the attitude that they can be actively involved in influencing their own future

(8) To help students to clarify and evaluate their own values and goals

(9) To help students to clarify and evaluate society's values and goals

(10) To help students understand the requirements for human survival

(11) To help students develop an understanding of mankind as a single human community

(12) To encourage students to commit themselves to action to improve present conditions in the world

(13) To develop in students the ability to integrate ideas and information originating in diverse disciplines

Moderate Degree of Acceptance

(14) To help students develop an optimistic attitude toward the future

(15) To help students develop an understanding of the world as a single globe system

(16) To enable and motivate students to share their futures studies knowledge and insights with others

(17) To help students develop human relations skills

(18) To give students an understanding of some of the basic concepts and methods employed by practicing futurists

(19) To help students appreciate the historic development and importance of human thought about the future

Other writers have more specific ideas concerning what the goals of a futures studies course should be. Rojas and Eldridge (1974) have compiled a list of alternative goals from a survey of "futurist" courses for adults that can be used to organize some of the prescriptions found in the literature:

(1) help students anticipate change, make better career choices, develop future-oriented attitudes (e.g., Torrance, 1975b, 1976a, 1976b)

(2) survey forecasting methods (e.g., Dede, 1974; Glenn, 1975; Peakes, Burnin, Cherniak and Dede, 1973)

(3) develop the ability to relate ideas and information between disciplines (e.g., Shane and Shane, 1974)

(4) facilitate student-to-student and student-to-teacher interaction (e.g., Pierce, 1972)

(5) Recognize the continuing impact of technology upon society (e.g., Kauffman, 1976b; Livingston, 1973; Olno, 1976)

(6) develop the ability to evaluate forecasts and utilize feedback to do so (e.g., Kauffman, 1976b)

(7) study major trends shaping the future (e.g., Kauffman, 1976b)

(8) explore ideas, images, models of the future (e.g., Livingston, 1971; Driessel, 1971)

(9) examine case study forecasts in specific problem areas (e.g., Livingston, 1973; Kauffman, 1976b; Cohen and Gustafson, 1975)

(10) develop alternative scenarios of the future (e.g., Torrance, 1976b; Strudler, 1974)

A focus on the future within the secondary school may take the form of a separate course, a unit of instruction within a course, or a broad unifying theme that runs across a number of subject matter areas. Likewise, there is considerable variety in the instructional approaches

employed. "Futurizing" the curriculum may mean science fiction readings, topical studies such as ecology or genetics, simulated environments, or training in forecasting techniques. Futures studies is mulitidisciplinary in nature and can and has been integrated across curriculum areas. Thus, a math teacher may introduce trend extraploation; a language arts teacher may involve students in writing scenarios; a social studies teacher may use environmental studies to investigate future uses of resources; a science teacher may invite experts to lecture on scientific and technological developments; and/or a guidance counselor may run seminars on future careers and changes in employment.

Kaufman (1976a) advocates a school-wide approach to future-oriented education. For Kauffman, such a program:

- begins with the student's own personal image of the future, working to strengthen it where necessary
- relates all subject matter to the future needs of the students
- apportions space in the curriculum to different subjects according to their relevance to the students' futures, explains the rationale for the curriculum choices to students, and allows the flexibility to accomodate differences in interests, ability, and future plans
- presents content in an interdisciplinary manner, emphasizing the underlying similarities of all living and social systems
- organizes the learning environment to stimulate creativity, self-motivated learning, and self-discovery

- emphasizes skills over knowledge, helping students learn "sciencing" as well as science, forecasting as well as forecasts - in short, thinking as well as facts

Research

As noted earlier, useful research in the area of futures studies and instruction is almost nonexistent. Singer (1974) points to some clinical studies that suggest a relationship between academic achievement and future orientation as measured by projective tests. For Singer, a person's "Future-Focused Role Concept," or the extent to which a person has an image of himself or herself in a future role, correlates positively with achievement in school, the avoidance of delinquency, and a feeling of optimism about the future. Toffler (1974) reports an informal study in which a group of high school students was asked to compose a list of future events as well as a list of events that might happen to them personally. The disconnectedness between these lists, that is, students' tendency to believe in dramatic world changes while projecting a conventional future for themselves, is viewed by Toffler as evidence that the majority of students have failed to personalize their expectations about social change. Toffler also cites studies conducted at Cornell and UCLA where groups of students were asked either to finish a story by telling what the characters did or finish it by describing what they will do. While the past-tense groups tended to write richly-detailed accounts, the story endings written by the future-tense groups were sketchy and brief. Toffler implicates the

past-centered curriculum for students' inability to be imaginative in the future tense.

Instruction in Futures Studies at the Secondary Level

The following classification scheme represents a rough taxonomy of the course descriptions, course outlines, and articles and books on teaching strategies that are currently available.[1]

Topical approaches. Most futures studies courses are organized according to topics. The topics seem to be chosen for their fertility for suggesting issues and problems associated with technological and social trends and changes. Popular topics include ecology, population, land use, the elderly, food, automation, and genetics (Olno, 1976; Cohan and Gustafson, 1975; Buchanan, 1970).

Science fiction. Kauffman (1976b) endorses the use of science fiction for stimulating the imagination and for introducing plausible alternative futures. Both Livingston (1971) and Driessel (1971) view science fiction to be central to a program in futures studies.

Teaching techniques of forecasting. Shane (1973) lists the techniques and devices used to construct forecasts as: (1) human reasoning, (2) the computer, (3) the Delphi methodology, (4) trend extrapolation, (5) simulation models, (6) scenarios, (7) multiple correlation and factor analysis, (8) cross-impact matrices, (9) trend impact matrices, and (10) experience compression techniques, e.g., simulations.

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[1] Besides the works cited in this section, six samples of unpublished high-school level programs were considered in the construction of this classification.

Most future studies courses use some of those techniques in some fashion, especially scenarios and trend extrapolation. Some developers view these techniques as central for identifying future trends, identifying consequences of trends, and exploring alternatives (Glenn, 1975; Glenn and Guy, 1974; Dede, 1974). Glenn reports success with students as young as grade five using the cross-impact matrix and the future wheel technique.

"Personalizing" the future. Among those writers and developers who emphasize the future-focused role image of students, the necessity to integrate students' personal and social projections of the future is viewed as the primary focus of future-oriented instruction (McDanield, 1974; Hollister, 1974; Torrance, 1975b). McDanield and Hollister emphasize value clarification while Torrance employs sociodrama as a means to this end.

Problem solving and divergent thinking techniques. The necessity to encourage the use of the imagination is a recurrent theme throughout the literature on futures studies. Bell (1974) recommends that students be led "to transcend past experience, to creatively invent the future..." (p. 76); Strudler (1974) describes the best of the futures studies courses as one "that would blend the 'science' of charting the probable with the art of imagining the possible..." (p. 175). McDanield and Mendall (1975) review two creative problem-solving models and recommend that all futurists combine methods of vertical (logical) thinking with techniques useful for fostering lateral (creative) thinking.

Toffler (1974) envisages an "action learning" futures studies course that involves students in solving future problems through the generation of alternatives, the development of plans, and a consideration of contingencies and consequences. Buchanan (1970) combines problem solving and decision making in a course focused on the year 2000. Torrance (1976a, 1976b) describes a future problem solving and career education course that incorporates the Osborn-Parnes creative problem-solving model, hypothetical future-oriented problems, and the use of scenarios and soliloquys as evaluation devices.

Multi-faceted approaches. Two handbooks on teaching futures studies deserve special mention in that they both incorporate a wide range of approaches. Both LaConte (1975) and Kauffman (1976b) combine science fiction, simulations, and instruction in the use of forecasting techniques. In addition, Kauffman recommends that a course in futures studies makes a deliberate attempt to alter students' beliefs about the future by teaching them some of the concepts, principles, and assumptions that guide the work of professional forecasters and planners.

Implications for Instruction

A thorough analysis of the literature on futures studies yielded a number of design specifications for the *Making Changes* program. Correspondence with Kauffman and Torrance was especially helpful in deciding on aspects of futures studies that are worthy of instruction and in determining a strategy for evaluating instructional effects. The following concepts and methods were included in the program as a direct result of the literature analysis:

- throughout the student materials on futures studies, there is a focus on a changing future, on alternative futures and on the malleability of the future;
- students are continually called upon to place themselves in hypothetical future situations and to consider the consequences for themselves as well as for others;
- a skill-based approach to instruction is maintained throughout the section on futures studies. Students learn to evaluate forecasts, extend trends, interpret trends, construct cross-impact matrices, write scenarios and generate future wheels;
- content areas and problems were selected for their global importance and for their relevance to students' futures;
- among the techniques of forecasting covered in the program, those that allow for the greatest use of the imagination are stressed the most;
- previous instruction in problem solving and in idea generation techniques is integrated with instruction in the use of forecasting techniques wherever appropriate.

GOALS AND OBJECTIVES FOR THE *MAKING CHANGES* PROGRAM

The goals and objectives of the *Making Changes* program span a number of psychological as well as content dimensions. For each of the two major content areas of the program, inventive problem solving and futures studies, performance objectives specify a range of kinds of learnings. This range extends from simple naming responses and familiarity with defined concepts at one end, to the autonomous use of learned strategies at the other extreme. Since the principal objectives of the *Making Changes* program are these cognitive strategies, a brief discussion of the peculiarities of strategies is called for.

Strategies are special kinds of cognitive skills. That is, they refer to learned capabilities and not items of information. But, unlike skills, they are not learned as ends in themselves. They are covert operations — sometimes simple, sometimes complex — that facilitate performance on some task of interest. In other words, strategies operate as mediators. They make it possible to do something easier, quicker or better but their use is neither necessary nor sufficient for success in the task. This characteristic of strategies as means rather than ends, makes it necessary to have multiple objectives and multiple assessment tasks for a strategy. For example, it might be necessary to: (1) present students with the strategy plus a full set of prompts and ask them to use it for some task or problem (basic mastery); (2) given a problem or task, ask students to produce and use the strategy (mastery plus recall); and (3) give students a problem to solve with no special

instructions (proficiency). Further variations on these assessment methods are possible using varieties of topics and problem types.

The following classification scheme is organized according to major goals of the program with types of objectives serving as subcategories. Note that objectives relating to attitudes, dispositions and group behaviors are included as a separate goal area.

Goals and Objectives

Making Changes Program

GOAL I: INVENTIVE PROBLEM SOLVING

- *Given a casually worded complaint and related information, the student will be able to:*
  - *i. locate the essential problem*
  - *ii. state that problem as a challenge(s)*
  - *iii. break the problem into its parts*
  - *iv. generate a broad, fertile problem definition*
  - *v. generate a large number of high quality ideas*
  - *vi. generate appropriate criteria for judging these ideas*
  - *vii. select a high quality idea for implementation*
  - *viii. generate ideas for putting the solution idea into action.*
- *The student should be able to carry out these steps with a continual alteration of free imagination and critical judgment.*
- *The student should be able to carry out these steps individually or as part of a group.*
- *The student should be able to conduct each step and the complete process with or without explicit prompts.*
- *The student should be able to select and use appropriate learned techniques at each stage of the process.*
- *The result in each case should be the production of many and varied high quality solutions.*
- *The student should be able to vary this problem solving process to make optional use of metaphorical and analogical thinking.*

OBJECTIVES

A. Knowing definitions, using basic concepts.
   1. Be able to give a definition of "habit thinking."
   2. Be able to select the best definition of "open-ended problems."
   3. Be able to discriminate open-ended problems from close-ended problems.
   4. Be able to identify definitions for the following terms:
      a. a "mess"
      b. explosion
      c. challenge statement
      d. verb change
      e. reversal
      f. broad terms
      g. group roles:
         (1) leader
         (2) recorder
         (3) liaison
         (4) reporter
      h. criterion/criteria

5. Be able to discriminate "blocks" from "aids" and be able to generate examples of each.
6. Be able to name and define the five criteria used in the program (cost, acceptability, resources, workability, consequences).
7. Be able to identify and describe each of the following idea generation techniques:
   a. brainstorming
   b. checklist
   c. checkerboard
   d. part-changing
   e. force fit
8. Be able to name the four rules of brainstorming (no criticism, think of many, many ideas, think of wild and unusual ideas, hitchhike on others' ideas).
9. Be able to select a definition for each of the following items:
   a. analogy
   b. analogy excursion
10. Be able to discriminate among and describe each of the following idea generation techniques:
    a. wish statements
    b. finding similarities
    c. personal analogy
    d. clash statement

B. Using strategies — applying the methods and techniques taught in the program.
1. Given a problem stated as a complaint, the students will be able to restate the problem as a challenge using:
   a. how
   b. verb change
   c. reversal
2. Given a problem stated as a challenge, the student will be able to generate multiple problem statements for the problem using the techniques of how, verb change and reversal.
3. Given a problem statement and associated information, the student will be able to break the problem into its parts using explosion. *These "parts" should include both concrete and abstract aspects of the problem.*
4. Given problem statements and the results of an explosion, the student will be able to select the best broad terms statement to serve as a problem definition for the problem.
5. The student will be able to generate a broad terms definition.
6. Given a problem, the student will be able to participate in and follow the rules of a brainstorming session.

7. Given a problem, the student will be able to use the no criticism rule to brainstorm on his/her own.
8. Given a problem involving how to improve an object or a system, the student will be able to use and/or construct and use the following techniques:
   a. part-changing method
   b. checklist
   c. checkerboard
9. Given a variety of ideas for a problem, the student will be able to generate additional ideas (combinations) using the techniques:
   a. force fit
   b. checkerboard
10. Given a complete set of solution ideas for a problem, the student will be able to select and/or generate a set of appropriate criteria for judging (evaluating) the ideas.
11. The student will be able to construct a criteria chart and judge any and all ideas according to a simple pass-fail system.
12. Given a problem that demands the discovery of some principle or combination of principles (or operations, methods, dynamic systems), the students will be able to:
    a. generate wish statements
    b. identify similarities (analogies) from the following domains:
       (1) animals
       (2) plants
       (3) other places/other times
    c. construct an explosion diagram
    d. identify "key words" from the explosion diagram
    e. conduct a personal analogy of the sort:
       (1) "be the thing"
       (2) "be an analogy"
       (3) "be the problem"
    f. generate "clash statements" as a result of personal analogy demonstrations
13. Given a problem, students will be able to carry out all the steps of an analogy excursion (objective no. 12) and do so with minimal guidance.

C. <u>Using the concepts, skills and techniques without explicit prompts.</u>
1. Given a nonspecific set of complaints, the student will be able to find and state the problem(s) underlying the complaints.
2. Given a variety of complaints and problem statements, the student will be able to redefine the problem as a challenge and do so in a variety of ways.

3. Given a problem statement that defines a problem in an unnecessarily narrow fashion, the student will be able to restate the problem definition in a broader fasion.
4. Given a variety of problem statements, the student will be able to generate a large number of high quality solution ideas in a short period of time.
   Note: For lack of a better index, the number of ideas (fluency), the variety of approaches employed (flexibility), and the quality of ideas produced — a combination of uniqueness and workability — (originality), will, when taken together, be considered to be evidence of mediated performance.
5. Given a variety of solution ideas and information about a problem, the student will be able to select a high quality idea and justify his/her choice with sensible and appropriate reasons.
6. Given a problem that requires the discovery of a new principle, operation or method, the student will be able to generate many and varied high quality solutions.
   Note: An inspection of students' solution ideas and/or self-report measures can be used to determine if analogies or other excursion techniques were used as mediators.

GOAL II: FUTURES STUDIES

- *Given information about a possible future development, the student will be able to:*
  - *i. evaluate the probable reliability of the forecast*
  - *ii. generate implications for the forecast (consequences)*
  - *iii. generate personal consequences for the forecast*
  - *iv. construct a total picture of how the world might be different if the development came about*
- *Given information about multiple forecasts, the student will be able to identify possible interactions between forecasts in terms of positive consequences, negative consequences and possible new developments.*
- *The student will gain some understanding of the methods employed by futurists, the beliefs held by futurists, and the major trends that may affect the future.*

OBJECTIVES

A. Knowing definitions; using basic concepts.
   1. The student will be able to identify four and name at least two reasons for studying the future:
      a. to be prepared for rapid growth and change
      b. to head off problems before they occur
      c. to look for long-term solutions
      d. to become aware of systems

2. The student will be able to give a definition for the following terms:
   a. futures studies
   b. futurist
   c. global awareness
   d. forecast
   e. trend
   f. expertise
   g. bias
   h. recency
   i. consistency
   j. impact
   k. matrix
   l. factor
3. The student will be able to name the four criteria for judging forecasts (expertise, bias, recency, consistency).
4. The student will be able to identify the defining attributes of:
   a. a forecast based on a trend
   b. an accelerating trend
   c. a Delphi forecast
   d. the cross-impact matrix
   e. scenarios
   f. future wheels

B. Using the concepts, skills and strategies taught in the course.
1. The student will be able to classify "future-oriented" plans as being examples or non-examples of each of the four reasons for studying the future (rapid growth and change, head off problems, long-term solutions, systems).
2. Given a set of forecasts, students will be able to judge their reliability using the four criteria for judging forecasts (recency, expertise, bias, consistency).
3. The student will be able to interpret a variety of graphed trends.
4. Given a graphed trend, the student will be able to extrapolate that trend to any given future date.
5. Given a graphed trend and information regarding how that trend might be affected by related developments, the student will be able to complete an appropriate trend extrapolation.
6. Given a graphed trend and a set of additional trends and possible developments, the student will be able to estimate how that trend might be affected by the developments and trends.
7. Given a graph of an accelerating trend, the student will be able to complete a trend extrapolation to any given future date.
8. Given a set of possible future developments or trends, the student will be able to fill in or construct and fill in a cross-impact matrix.
9. The student will be able to use a cross-impact matrix to identify positive impacts (consequences), negative impacts (consequences), or possible new developments (needs or ideas).

10. Given a set of possible developments, the student will be able to write a scenario describing life in the future which describes the consequences and implications of these developments for both the social order and for the student's personal life.
11. Given a possible future development, the student will be able to fill in or construct and fill in a future wheel.

C. Using the concepts, skills and strategies without explicit prompts.
   1. Given a variety of information — graphed trends, forecasts made by individuals, forecasts made by groups — the student will be able to:
      a. identify and discuss possible implications and consequences of these trends and forecasts
      b. identify and discuss possible "cross-impacts" of these trends and forecasts
      c. identify and discuss possible problems, needs and additional developments revealed or implied by these trends and forecasts
   2. Given information regarding a possible future development, the student will be able to describe its possible "meaning" in terms of:
      a. a list of direct positive and negative consequences
      b. a list of second and third order consequences
      c. a description of the personal implications of the development
      d. an understanding of the interrelationships among this and other developments and trends

Note: Whether or not students use the strategies taught in the program to complete these criterion performances cannot always be measured directly. An inspection of the fluency, flexibility and originality of students' responses can be used to make inferences regarding the impact of the strategies.

GOAL III: ATTITUDES AND DISPOSITIONS

- *The student will develop positive attitudes towards problem-solving activities and the type of thinking required for open-ended problems. Relatedly, the student will develop the disposition to enter into problem-solving activities and to persevere at problem-solving tasks in the absence of direct environmental support.*
- *The student will develop an attitude/belief system regarding the future (future orientation) characterized by an appreciation of change, a belief in the mutableness of the future and realism regarding possible future problems. Relatedly, the student will develop a personal future orientation that is consistent with his/her orientation towards societal futures.*

- *The student will develop positive attitudes toward and a disposition to engage in group work. As a result of participation in group work, the student will develop an increased tolerance of others' ideas and of divergent ideas, increased self-confidence and willingness to be an active participant in small-group work and increased satisfaction regarding the worth of group activities.*

OBJECTIVES

A. Problem solving.
   1. Students will develop a more positive attitude toward:
      a. engaging in problem solving
      b. thinking of ideas
      c. unusual ideas
      d. the worth of problem solving
      e. their effectiveness at thinking of ideas
      f. their effectiveness at solving problems
   2. The student will develop a disposition to:
      a. engage in problem-solving activities
      b. persevere at problem-solving activities
      c. avoid "habit thinking" (functional fixedness)
      d. be open to and tolerant of diverse, unusual ideas
      e. consider alternative methods of approaching a task or reaching a solution
      f. become more independent, less conforming, less consensus oriented in a problem-solving task

B. Futures studies.
   1. Students will develop a more positive attitude toward:
      a. futures studies as a vocation or avocation
      b. mankind's ability to influence, change the future
      c. their ability to influence their future
   2. Students will show changes in their belief structure relating to:
      a. the importance of imaginativeness in forecasting
      b. the salience of world problems
      c. the dangers of exponential growth
      d. the dangers of shortsightedness
      e. the importance of looking at alternatives in futures studies
      f. the degree of change to expect in the future
   3. Students will develop a disposition to:
      a. engage in discussion of alternative futures
      b. see themselves as agents and embodiments of change
      c. avoid "jumping to conclusions" about the future
      d. avoid authoritarianism and pessimism regarding the future
      e. be more fluent, flexible and original in their speculations regarding the future.

C. Group Activities.

1. The student will develop a more positive attitude toward:
   a. working in a group
   b. others' ideas
   c. cooperating in a group
   d. their ability to participate in or lead a group activity
   e. the importance of deferred judgement (refraining from criticizing) in a group activity
2. The student will develop a disposition to:
   a. engage in group activities
   b. persevere at a group task
   c. cooperate and share responsibilities in a group task

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